



## Tuesday 11 June 2019 - Morning

## **A Level Computer Science**

H446/02 Algorithms and programming

Time allowed: 2 hours 30 minutes

# You may use: • a ruler (cm/mm) • an HB pencil Do not use: · a calculator



Please write clearly in black ink. Do not write in the barcodes.									
Centre number						Candidate number			
First name(s)									
Last name									,

#### **INSTRUCTIONS**

- Use black ink.
- Answer all the questions.
- Write your answer to each question in the space provided. Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).

#### **INFORMATION**

- The total mark for this paper is 140.
- The marks for each question are shown in brackets [ ].
- Quality of extended responses will be assessed in questions marked with an asterisk (\*).
- This document consists of 24 pages.



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## **Section A**

1	The temperatures of an ocean are input into a computer system. They are recorded, and will be
	accessed, in the order in which they arrive. The data for one week is shown:

5, 5.5, 5, 6, 7, 6.5, 6

(a)	The	data is to be stored in a data structure. The programmer stores the data in a queue.
	Ехр	lain why a queue is used instead of a stack.
		[2]
(b)		data is processed. After processing, the value for the first day is stored as 0. The value each following day is stored as an increase, or decrease, from the first day.
		example: if the first day was 7, the second was 6 and the third was 9, after processing it lid be stored as $0, -1, 2$ .
	(i)	The queue uses <code>dequeue()</code> to return the first element of the queue.
		dequeue() is a function.
		Explain why dequeue() is a function, not a procedure.
		[1]
	(ii)	Complete the algorithm to process the data in the queue and store the results in an array called ${\tt processedData}$ .
		<pre>processedData[0] = 0</pre>
		firstDay =
		for count = 1 to 6
		processedData[] = dequeue()
		next count [3]
		[2]

(iii) The contents of processedData are show	(iii)	(
--	-------	---

0	0.5	0	1	2	1.5	1

The data needs to be sorted into ascending order.

	<b>Explain</b> proces			algorithm nation.	sorts	data.	Use	the	current	contents	of
re		 	 								

(iv) A bubble sort has the following complexities:

Best time	O(n)
Average and worst time	O(n <sup>2</sup> )
Worst space	O(1)

Describe what each of these complexities mean.
Best time O(n)
Average and worst time O(n <sup>2</sup> )
Worst Space O(1)
[6]

**2** A program needs to store the names of plants that are in a garden, so they can be easily found and accessed in alphabetical order.

The data is stored in a tree structure. Part of the tree is shown.

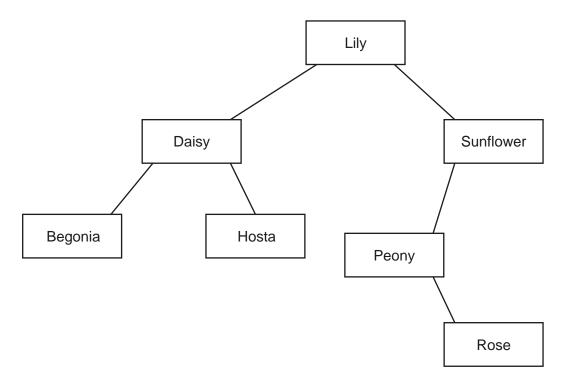


Fig. 2.1

(i)	State the type of tree shown in Fig. 2.1.
	[1]
(ii)	Show the output of a breadth-first traversal of the tree shown in Fig. 2.1.
	[31

(iii)	Explain how backtracking is used in a depth-first (post-order) traversal. Use the tree in Fig. 2.1 in your explanation.
	[4]

- (b) The elements in the tree in Fig. 2.1 are read into a linked list producing an alphabetised list.
  - (i) Complete the following table to show the linked list for the data.

Data item	Data	NextPointer
0	Begonia	
1	Daisy	
2	Hosta	
3	Lily	
4	Peony	
5	Rose	
6	Sunflower	

(ii) A new plant, Lavender, needs adding to the linked list. The linked list needs to retain its alphabetical order.

Complete the table to show the linked list after Lavender is added.

Data item	Data	NextPointer
0	Begonia	
1	Daisy	
2	Hosta	
3	Lily	
4	Peony	
5	Rose	
6	Sunflower	

[3	3	

(iii)	Hosta needs	removing from	the linked list.
-------	-------------	---------------	------------------

Explain how a data item is removed from a linked list. Use the removal of Hosta in your answer.
[4]

(iv)	The linked list is stored as a 2D array with the identifier plantList. The index of the first element of the linked list is stored in the identifier firstElement.
	All contents of the linked list need to be output in alphabetical order.
	Write an algorithm to follow the pointers to output the contents of the linked list in alphabetical order.
	Add comments to explain your code.

.....[5]

9

**3** A recursive function, GCD, is given in pseudocode.

```
function GCD(num1, num2)
    if num2 == 0 then
         return num1
    else
         return GCD(num2, num1 MOD num2)
    endif
endfunction
(a) The function uses branching.
   Identify the type of branching statement used in the function.
    .....[1]
   Explain the difference between branching and iteration.
   .....[2]
   Identify the two parameters in the function.
   1.....
   2.....
                                     [1]
 (iv)
   State whether the parameters should be passed by value, or by reference. Justify your
   answer.
    .....[2]
```

	(v)	Describe the arithmetic operation of MOD. Use an example in your answer.	
			[2]
(b)		ce the recursive function when it is called by the statement $\mbox{GCD}(250,\ 20)$ . We returned.	Give the final
	Fina	al return value:	[3]
(c)	The	function has been rewritten using iteration instead of recursion.	
	(i)	State <b>one</b> benefit and <b>one</b> drawback of using iteration instead of recursion.	
		Benefit	
		Drawback	
			[2]

(ii) Complete the missing statements in this iterative version of the function.

function newGCD(num1, num2)
temp = 0
while (num2 !=)
= num2
num2 = num1 MOD
num1 = temp
endwhile
return
endfunction

[4]

- 4 Mabel is a software engineer. She is writing a computer game for a client. In the game the main character has to avoid their enemies. This becomes more difficult as the levels of the game increase.
  - (a) Mabel uses decomposition to design the program.

xplain how decomposition can aid the design of this program.	
	••••
	••••
	<b>[2</b> ]

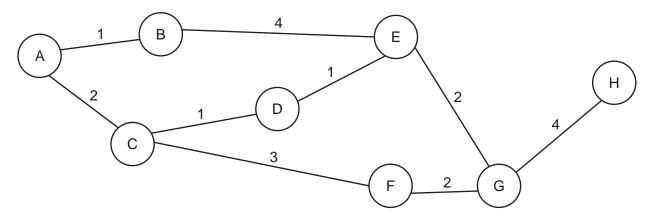
**(b)** The computer game allows a user to select a character (e.g. name, gender). They can then choose a level for the game (easy, normal, challenging). The user controls their character by moving it left or right. The character can jump using space bar as an input. If the character touches one of the enemies then it loses a life. The character has to make it to the end of the level without losing all their lives.

The game is designed in a modular way.

(i)	One sub-procedure will handle the user input.
	Describe three other sub-procedures Mabel could create for the given game description.
	1
	2
	3
	[6]
(ii)	Describe the decision that the program will need to make within the user input sub- procedure and the result of this decision.
	[2]
(iii)	Define pipelining and give an example of how it could be applied in the program.
	[2]

(c) The game's 'challenging' level has intelligent enemies that hunt down the character in an attempt to stop the user from winning. The program plans the enemies' moves in advance to identify the most efficient way to stop the user from winning the game.

The possible moves are shown in a graph. Each node represents a different state in the game. The lines represent the number of moves it will take to get to that state.



Show how Dijkstra's algorithm would find the shortest path from A to H.
[6]

(d)* Mabel has been told that true programmers write programs in a text editor, and do not use IDEs. Mabel does not agree with this statement.	е
Discuss the use of an IDE in the development of this program.	
	٠.
ro	

**5** A 1-dimensional array stores the following data:

Index	0	1	2	3	4	5
Data	2	18	6	4	12	3

(a)	The array needs sorting into descending order.
	Describe how a merge sort would sort the given array into descending order.
	[6]
(b)	An insertion sort can be used to sort the array instead of a merge sort.
	Explain why an insertion sort might use less memory than a merge sort.

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.....[2]

Evaluate website.	the use	of data	mining 1	o help	Benedict	enhance	and	improve	his	social	networking
											[9]

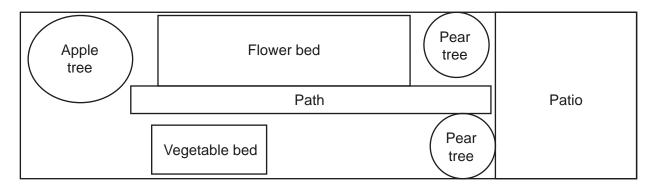
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### 18 Section B

7 A program is needed to plan the layout of a garden.

The program will allow the user to create an image of the garden, for example:



- (a) The programmer will use abstraction to produce the program interface to represent the garden.

Give two different examples of how abstraction has been used to produce the layout of

[3

(i)

(iii)	The user needs	to input data into the program to set ι	up their garden layout.				
	Identify three pie	eces of data that the user may input in	nto this program.				
	1						
	2						
	3						
The	nrogram is to be	built using object oriented programm	aina				
	program to to bo	zan acıng ezjeci enemea programm	9.				
The	e class has the foll	owing attributes:					
	Attribute	Description	Example				
it	cemName	The name of the item	Flowerbed				
16	ength	The length of the item in metres	2				
wi	idth	The width of the item in metres	1				
(i)	Write pseudocod	method sets the attributes to values the or program code to declare the class ould be private and initialised through em("Flowerbed", 2, 1)).	ss GardenItem and its constru				

(ii)	The trees in the garden layouts are defined by the class Tree. This class inherits from GardenItem.
	The class Tree has the additional attributes: height, sun, shade.
	If sun is true then the tree can grow in full sun, if it is false then it cannot.
	If shade is true then the tree can grow in full shade, if it is false then it cannot.
	The length and width of a tree are the same. Only one value for these measurements is passed to the constructor.
	Write an algorithm, using pseudocode or program code, to declare the class Tree Declare all attributes as private.

(iii)	The Common Oak is a type of tree. It has a maximum height, length and width of 40 m. It can grow in sun and shade.
	Write a statement, using pseudocode or program code, to declare an instance of tree for the Common Oak. Give the object the identifier firstTree.
	[4]
(iv)	The classes ${\tt GardenItem}$ and ${\tt Tree}$ use get and set methods to access and alter their private attributes.
	Write the get method getItemName and set method setItemName for class GardenItem. The set method takes the new value as a parameter.
	Do not write any other methods, or re-declare the class.
	[4]

(v) The trees in the garden layouts are stored in a 1-dimensional array, treeArray. The array can store a maximum of 1000 items. The array has global scope.

A procedure, findTree, takes as parameters:

- The maximum height of a tree
- The maximum width of a tree
- Whether the tree can live in full sun
- Whether the tree can live in full shade.

It searches the array, treeArray, for all trees that do not exceed the maximum height and width, and that can grow in the conditions available. If there are no suitable trees, a suitable message is output.

It outputs the name and details of the trees found in an appropriate message.

Call the get methods, getItemName, getHeight, getWidth, getSun, getShade, to access the attributes.

Write, using pseudocode or program code, the procedure findTree.
[6]

(c)*	The programmer is designing the program to make use of caching and re-useab components.	ole
	Explain and evaluate the use of caching and re-useable components in the design of the garden program.	he

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